Production And Use Of WOOD CHIPS From Virginia Pine Thinnings

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The Production And Use Of WOOD CHIPS From Virginia Pine Thinnings

by

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IN MOST FOREST-MANAGEMENT plans, attention is usually directed to certain cultural treatments early in the life of a stand. These are generally some form of weeding or thinning to favor the ultimate crop trees by cutting out a proportion of the young stand that seems least desirable to retain.

Such cuttings, properly applied, can exert a very favorable effect on the residual stand. Unfortunately, under present concepts of utilization they do not yield merchantable products. There is no established market for woods-run small trees not over 3 or 4 inches in diameter. Therefore, if the cultural work is done, it can be considered only as an investment in the woodland, an investment that may not pay off for many years.

Although these small trees can seldom be sold "as is," an encouraging possibility is developing: marketing

[1]Stationed at the Virginia Pine-Hardwood Research Center, Beltsville, Md.

them in the form of chipped wood.

Light, portable wood chippers, now in commercial production and available at moderate cost, are capable of reducing brush, saplings, and small-size pole trees into fine or coarse fragments at a high rate of speed. In turn, the chips have potential value, particularly in agriculture, as bedding, litter, and soil conditioner. It follows that if chipped wood produced from thinnings can be sold and used in various ways, then the cost of cultural treatment may be recovered. This depends on the sale price of the chips as compared to the cost of producing them.

A study has been made at the Virginia Pine-Hardwood Research Center in Maryland to investigate various aspects of thinning, chipping, and use of the chips. The objectives of the study were: (1) to determine the labor requirements for early thinning in Virginia pine; (2) to determine the volume per acre of wood removed in the thinnings; (3) to determine the costs and productive rates of converting the wood into chips; and (4) to determine, through cooperative tests, the usefulness of chips as cattle bedding and poultry litter.

EXPERIMENTAL METHODS

A characteristically dense, limby stand of Virginia pine approximately 17 years old (fig. 1) was selected for a thinning study. Two plots were used. Plot 1 was thinned and the products of the cutting were taken out for chipping (fig. 2). Plot 2 was only thinned, and the thinnings were left on the plot (fig. 3). Each plot was 60 by 363 feet or $\frac{1}{2}$ acre in size. This long and narrow shape was chosen because it appeared to lend itself better to portable chipping operations.

All trees cut in the thinnings were 1 to 4 inches in diameter. The cutters were instructed to strive for an average spacing of 7 to 8 feet between crop trees.

Practically all trees removed from the stand were suppressed or intermediate. A very few in higher crown classes were cut because of pronounced sweep, crook, or forking. No dead trees were cut or chipped. In Plot 1 a total of 25.5 square feet of basal area were removed, leaving 65.8 square feet per acre. In Plot 2 a total of 31.7 square feet were removed, leaving 79.7 square feet per acre.

A 4-man crew, using axes, made the thinnings. On Plot 1 the selected trees were felled, cleanly limbed and

topped, and then cut to lengths of 10 to 15 feet. One or more of these poles, depending on their size, were then carried by hand to the chipping sites along an old road paralleling the plot, and were piled there at right angles to the road. The average yarding distance was about 35 feet.

On Plot 2 the trees were felled or girdled and nothing further was done with them. This thinning removed fewer trees, but the basal area cut was somewhat larger than in Plot 1. As these factors tend to offset each other, it is felt that they did not influence the comparative labor requirements for the two thinnings.

Figure 1.--A typical stand of Virginia pine about 17 years old. This is how it looked before it was thinned.

LABOR REQUIREMENTS

On Plot 1, 53 man-hours per acre were required to fell, limb, cut to length, and yard to roadside the trees removed in the thinning. On Plot 2, where no material was removed, only 12 man-hours per acre were required.

The additional work on Plot 1 accounted for the much greater labor requirement. The extra operations were not timed separately; but it is estimated that limbing alone was

Figure 2.--The cut trees were removed from this plot (Plot 1) after thinning. Here 838 trees per acre were taken out for chipping; 774 trees per acre were left.

Figure 3.--On this plot (Plot 2) the trees cut were left on the ground and the trees girdled were left standing. Here 718 trees per acre were cut or girdled; 746 trees per acre were left.

responsible for approximately two-thirds of the added work, the hand-yarding for the other one-third. Some time was also consumed in getting cut trees to the ground in these dense stands of Virginia pine. Limbing was a necessary requirement since the wood was to be chipped for cattle-bedding tests; for this use the presence of twigs and needles was considered undesirable. Otherwise, limbing would not have been required because the chipper can handle entire small trees.

WOOD AND CHIP YIELD

The polewood yarded to the chipping sites was not ranked for direct volume measurement. Instead, the yield was determined by measuring the total chip volume produced and then applying a conversion factor for solid volume.

Using this method, it was found that the volume of wood removed in the thinnings was approximately 6.9 standard cords per acre. This measure was obtained by ejecting the chips into a high-sided dump truck of known capacity and weighing each load. On a per-acre basis, 1,660 cubic feet of green chips were produced, weighing 34,200 pounds.

Previous studies showed that solid wood, converted into relatively fine chips by a machine similar to the one used, expanded to three times its original volume.[2] Using this ratio, we estimated that 1,660 cubic feet of chips were equivalent to 550 cubic feet of solid wood. Assuming that a standard cord contains 80 cubic feet of wood and bark, we figured that the thinning yield was therefore nearly 7 cords per acre.

CHIPPING PRODUCTION RATES AND COSTS

The chipping equipment and crew consisted of the following:

1. Fitchburg wood chipper, Model C-9, 6 knives, powered by a 60-hp. gasoline engine, both units mounted on a 2-wheel trailer. This machine has a drum-type cutter head with operating action similar to that of a planer.

2. A 1½-ton dump truck with built-up sides, to tow the chipper, receive chips from the discharge chute, and deliver them for the use trials.

3. A 2-man crew, sufficient to feed the chipper at full capacity.

In producing the required bedding chips, serrated knives were installed in the chipper and were set for a minimum clearance of 1/16 inch. This combination of knife type and setting resulted in a comparatively low production

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[2] Fenton, R.H., and McKusick, H.A. A pilot study of a portable wood chipper. U.S. Forest Serv. Northeast. Forest Expt. Sta., Sta. Paper 37. 18 pp., illus. 1950.

rate, but it was necessary for producing as fine a chip as possible.

During the chipping operations, a record was kept of production time. On an acre basis, the total time required for a 2-man crew to chip the material cut was 7.37 hours. Since the total chip yield was 1,660 cubic feet, the productive rate was 225 cubic feet per hour. And since their total green weight was 17.1 tons, these chips were produced at a rate of 2.32 tons per hour. This production rate was similar to that obtained with hardwoods in the Lake States.[3]

Table 1.--Costs of converting small standing pine to wood chips, based on volume and weight of chips

Operation	Unit costs			
	Per 100 cu.ft.	Per ton		Per hour
		Green	Dry	
Material preparation	$3.19	$3.10	$6.08	$4.00
Chipping	1.50	1.45	2.86	3.37
Total	$4.69	$4.55	$8.94	$7.37

Weight of wood in solid or chipped form is highly variable, because of wide ranges in moisture content. A field test was conducted later to ascertain the weight of chips from Virginia pine polewood cut at the same time and from the same area described previously, but not chipped until after 5 months of air-seasoning. These chips weighed 10.5 pounds per cubic foot, those from the freshly cut poles 20.6 pounds. In terms of air-dry weight, then, the total chip production was 8.7 tons, produced at a rate of 1.18 tons per hour.

Chipping costs include the labor charge for two men at $1 per hour, plus operating cost of the chipper. An

[3]Arend, J.L., Smith, R.N., and Ralston, R.A. Tests of a portable chipper. U.S. Forest Serv. Lake States Forest Expt. Sta., Sta. Paper 30. 35 pp., illus. 1954.

hourly rate of $1.37 was ascribed to the chipper: $0.32 for depreciation, $0.75 for operation, and $0.30 for maintenance. Table 1 shows the separate and total costs of the two work phases required to convert standing trees to wood chips. The total costs are for chips delivered into a truck at the chipping site. For a private operation items such as insurance and social security would have to be added to these costs along with delivery charges.

CHIP USE TESTS

Some of the wood chips produced in the study were put to a practical test of their value for cattle bedding. Others, plus additional chips made to different specifications, were used in two separate trials as poultry litter. Cooperating in these tests were the Dairy Husbandry Research Branch and the Animal and Poultry Husbandry Research Branch of the Agricultural Research Service, Beltsville, Md., and the Department of Poultry Husbandry at the University of Maryland, College Park, Md.

CHIPS FOR CATTLE BEDDING

The bedding chips were tested to determine whether they could be useful as bedding for dairy cattle. A test was also made of their value compared to standard bedding of air-dry sawdust and planer shavings. Figure 4 shows the comparative size and appearance of the two bedding materials used.

These trials were made in a conventional stanchion-type dairy barn. A summary of the trial and comparison is as follows:

Material	Animals	Days	Volume used	Weight used
	No.	No.	Cu.ft.	Pounds
Wood chips	11	24	580	9,672
Sawdust	11	24	580	7,056

Based on weight, 37 percent more wood chips than sawdust was required to provide satisfactory bedding conditions. Volumes used, however, were the same.

Observations made by the dairy husbandry people indi-

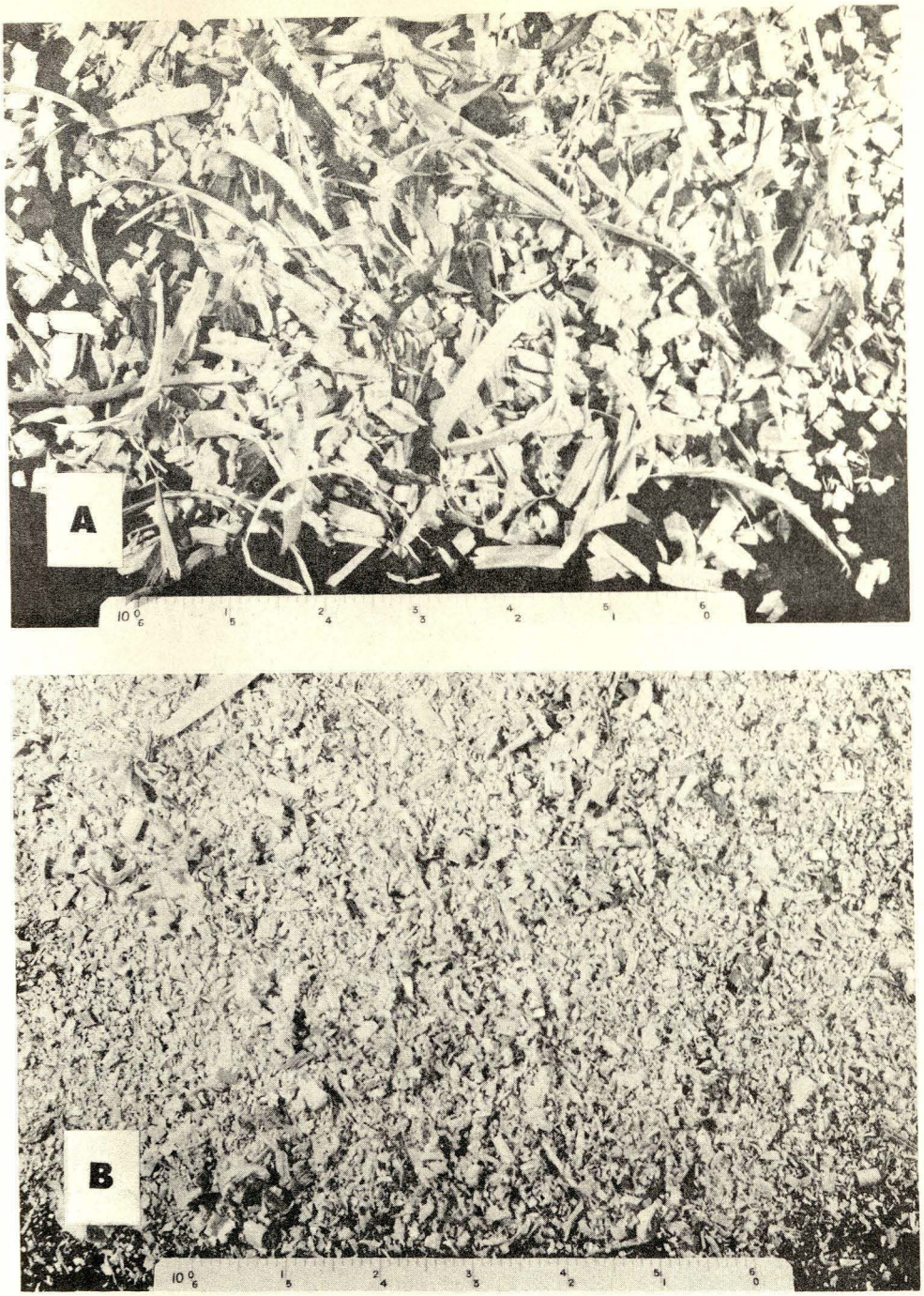

Figure 4.--These two materials were compared in tests for use as cattle bedding and poultry litter.

A, wood chips produced from green Virginia pine thinnings, with a serrated-knife setting of 1/16 inch.

B, a mixture of dry sawdust and shavings. This kind of material is used commonly for cattle bedding.

cated that the wood chips did not maintain as dry a condition in the stalls and gutters as did the sawdust. As a result the animals appeared to stay cleaner with the sawdust. It was felt, however, that the minor differences between the two beddings would have been eliminated had the wood chips been air-dried prior to use. In this respect, it was noted that the average cubic-foot weight of the chips had dropped from the original 20.6 pounds to 16.7 pounds when used. This occurred in only a few days' time, indicating the rapidity with which chips lose moisture.

Although the sawdust bedding appeared somewhat more satisfactory than the chips, the opinion was expressed that, if dry sawdust or shavings were unavailable, these green wood chips would be acceptable substitutes. If, however, a reliable supply of air-dry chips could be provided, then the primary factor influencing the choice of bedding material would be cost.

CHIPS FOR POULTRY LITTER

Tests In Cooperation With
Agricultural Research Service

Two sizes of chips were tested by the Animal and Poultry Husbandry Research Branch at Beltsville, Md. It was specified that air-dry material be supplied, so the chips were manufactured from Virginia pine polewood that had been cut 5 months before chipping.

One hundred eighty cubic feet of chips produced with serrated knives set for 1/16 inch were placed in one poultry house. In an adjacent similar house, 130 cubic feet of chips were applied. These were somewhat coarser than the first lot because a setting of 1/8 inch with serrated knives was used.

These chips were applied in early summer to a depth of 4 to 5 inches on a clean concrete floor. The two houses measured 20 by 20 feet each. Two additional houses were supplied at the same time with dry sawdust mixed with some shavings. An average of 100 chickens was kept in each house for the duration of these tests.

The chip litters and the sawdust were used approximately 6 months. By that time it was apparent they were in need of replacement. Inspection of these litters after 6 months' use did not show any appreciable difference between the two chip sizes and the sawdust. All were dirty, dusty, and their useful life ended.

The over-all opinion of the poultry research people was that the chips supplied them would generally be quite satisfactory as a litter. Basic requirements are that any material used for poultry litter should have good insulating qualities, resist packing and matting, have high moisture-absorbing quality, be composed of small-sized particles, and be reasonably dry--the drier the better. Of equal importance is the cost of litter, but this was not an inherent part of the test, although from a practical standpoint it would be a highly important factor. Related to cost is the length of service that litter gives before needing replacement; this depends on the number and kind of birds housed as well as the basic durability of the litter.

Although the wood chips proved to be satisfactory as a poultry bedding, the poultry people expressed a slight preference for their usual type of litter, which is sawdust with some planer shavings mixed in. Their chief observation was that the chips, of both sizes supplied, did not appear to absorb the moisture present in the droppings to the same degree that the sawdust did. The manure, therefore, tended to remain somewhat more wet and sticky than when dropped on the sawdust litter. This generally resulted in dirtier pens and birds.

The probable reason for the lower absorptive quality of the chips is that the individual fragments are considerably larger than the particles of sawdust. With equal volumes of litter, the surface area presented by the sawdust particles would be considerably greater than the surface area of the chips. Part of the chips supplied were as small as could be made by the chipper used; these did not compare in fineness to the sawdust but more closely approximated the shavings.

Tests In Cooperation With
University Of Maryland

A second cooperative test of wood chips was conducted at the University of Maryland's Department of Poultry Husbandry. For this test, different types of chips from those used in the trials described above were provided.

In two small poultry houses, 6 by 10 feet in size, approximately 40 cubic feet of chips were applied in each. These chips were made from freshly cut pine and hardwood saplings and brush. Serrated knives set for a 1/16-inch clearance were used. The material was not limbed, so the litter contained leaves, needles, and twigs as well as solid wood fragments (fig. 5).

Figure 5.--These wood chips were tested for their suitability as poultry litter. The material came from Virginia pine thinnings.

A, chips produced from whole green trees, with chipper knives set for 1/16 inch.

B, chips made from partially seasoned limbed trees, with knives set for 1/8 inch.

This litter was applied to the small pens in the fall, to a depth of 4 to 5 inches. These pens housed about 15 hens each. By midwinter it became obvious that this litter was not satisfactory, so it was discontinued after only 3 months' use. It had a decided tendency to cake and mat when used; this is considered a very undesirable characteristic in any poultry litter. It appeared that the admixture of twigs, needles, and leaves tended to bind the litter together; this, plus its green condition, was responsible for its failure.

In another house, 20 by 20 feet in size, approximately 120 cubic feet of chips were applied in late summer to a depth of about 4 inches. These were made from semi-seasoned pine polewood, using straight knives set for 1/8-inch clearance (fig. 5). This house contained 100 white leghorn pullets. It was used for one year, during which time no additional litter was needed.

This litter was considered successful. It remained in good condition throughout the 1-year test and at no time required extensive renovating to keep it in good condition. There was no tendency for it to cake. This litter was composed of a mixture of fine and coarse material, characteristic of chips produced by a drum-type machine. This lack of size uniformity was apparently advantageous in that the coarse chips remained on the surface while the fine material sifted to the bottom. The coarser chips, however, were not so large as to prevent chickens from scratching and moving the litter satisfactorily.

A possible criticism is that there seemed to be a comparative lack of absorptive ability in the chips that remained at or near the top. The result was more soiled eggs than is desirable. Aside from this, however, the performance of this litter was adequate under the conditions of the test.

SUMMARY

1. Two plots were established in a 17-year-old stand of pure Virginia pine in Maryland. Each was thinned from below, removing about one-half of the stems in each. All trees cut from one plot were removed and chipped with a portable chipper. Those from the second plot were merely felled or girdled and left on the plot.

2. On a per-acre basis, the first plot required 53 man-hours to fell, limb, and hand-yard the material to the chipper. The second plot needed only 12-man-hours for

felling and girdling. This wide difference was due primarily to extra time used in limbing and hand-yarding trees to the chipping locations.

3. The yield from the thinned plots was approximately 7 standard cords per acre. As chipped wood, the yield per acre was 1,660 cubic feet of chips weighing 17.1 tons. On an air-dry basis, the yield by weight was 8.7 tons. These yields were obtained by cutting intermediate or suppressed trees under 4 inches in diameter.

4. Chipping costs, for a 2-man crew and operation of the chipper, were $3.37 per productive hour. The output of chips, made as fine as possible, was found to be 225 cubic feet per productive hour. This was equivalent to 2.32 tons green weight, or 1.18 tons dry weight, per hour. Based on these outputs, the cost of producing chips was $1.50 per 100 cubic feet, $1.45 per green ton, and $2.86 per air-dry ton.

When the thinning costs, including limbing and yarding to the chipper, were added to these, the total cost from stump to truck was $4.69 per 100 cubic feet, $4.55 per green ton, or $8.94 per air-dry ton of chips.

5. The chips were put to practical tests to evaluate their use as cattle bedding and poultry litter.

Chips used as cattle bedding were produced with serrated knives set for 1/16 inch from green Virginia pine polewood. The primary objection noted was the lower absorptive quality of these chips compared to dry sawdust and shavings. Otherwise, they were a satisfactory material.

Four tests were made of chips for poultry litter, using both green and air-dry chips made with different knife types and settings. Only one of these litters was unsatisfactory. It was made from green unlimbed brush and small trees. Its failure was apparently due to the presence of many twigs and needles that tended to bind the litter together. The other three litters were considered satisfactory, one giving excellent service. These were made from limbed polewood that had been air dried before chipping.